PB-239 660

POWDER MILL POND, HILLSBOROUGH COUNTY, NEW HAMPSHIRE

Pacific Northwest Environmental Research Laboratory

Prepared for:

National Environmental Research Center
New Hampshire National Guard
New Hampshire Water Supply and Pollution Control Commission

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16. ABSTRACT
Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivded according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

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REPORT

ON

POWDER MILL POND

HILLSBOROUGH COUNTY

NEW HAMPSHIRE

EPA REGION I

WORKING PAPER No. 14

WITH THE COOPERATION OF THE

NEW HAMPSHIRE WATER SUPPLY AND POLLUTION CONTROL COMMISSION

AND THE

NEW HAMPSHIRE NATIONAL GUARD

AUGUST, 1974

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F O R E W O R D

The National Eutrophication Survey was initiated in 1972 as a research project in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to fresh water lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's fresh water lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the New Hampshire Water Supply and Pollution Control Division for professional involvement and to the New Hampshire National Guard for conduct of the tributary sampling phase of the Survey.

William A. Healy, Executive Director of the New Hampshire Water Supply and Pollution Control Commission, Ronald E. Towne, Water Pollution Biologist, and Kenneth MacDonald, Chief Water Pollution Sanitarian, provided invaluable lake documentation and counsel during the course of the Survey.

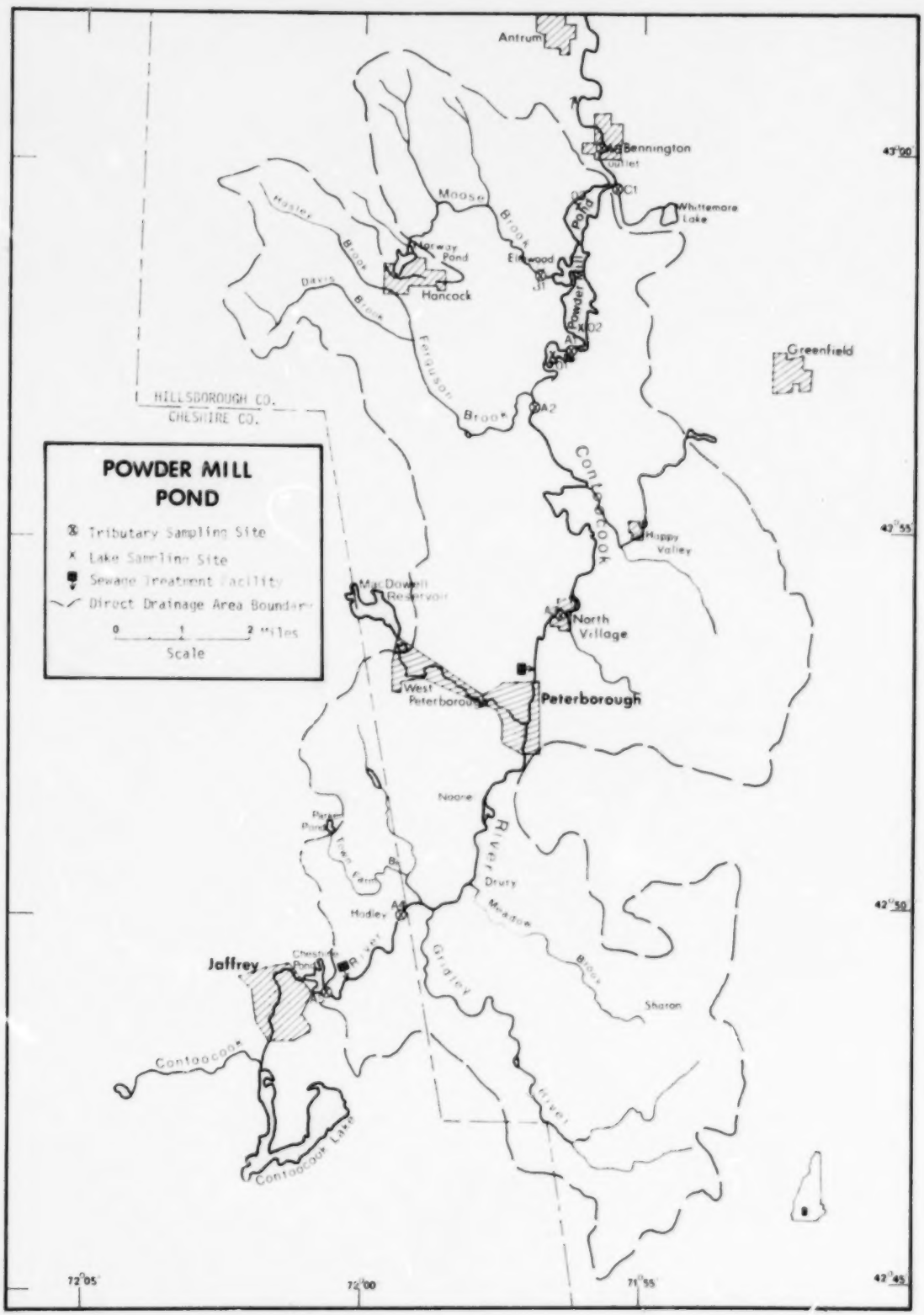
Major General Francis B. McSwiney, the Adjutant General of New Hampshire, and Project Officer Lieutenant Colonel Russ Grady, who directed the volunteer efforts of the New Hampshire National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF NEW HAMPSHIRE

LAKE NAME	COUNTY
Glen Lake	Hillsborough
Lake Winnipesaukee	Carroll, Belknap
Kelly's Falls Pond	Hillsborough
Powder Mill Pond	Hillsborough


POWDER MILL POND
Tributary Sampling Site
Lake Sampling Site
Sewage Treatment Facility
Direct Drainage Area Boundary
0 1 2 Miles
Scale
HILLSBOROUGH CO.
CHESHIRE CO.
Antrum
Bennington
Outlet
Whittemore Lake
Moose Brook
Powder Mill Pond
Eastwood
Hancock
Greenfield
Ferguson Brook
Contoocook
Happy Valley
MacDowell Reservoir
North Village
West Peterborough
Peterborough
Noone
River
Drury
Meadow Brook
Sharon
Hadley
Jaffrey
Gradient
Contoocook
Contoocook Lake
72°05'
72°00'
71°55'
42°45'
42°50'
42°55'
43°00'

POWDER MILL POND

STORET NO. 3302

I. CONCLUSIONS

A. Trophic Condition:

Survey data and the records of others show that Powder Mill Pond is eutrophic. Although algal blooms are rare, rooted aquatic vegetation is common to abundant in the shallower parts of the Pond. Apparently, the short hydraulic retention time suppresses trophic responses to relatively high nutrient loading rates.

B. Rate-Limiting Nutrient:

At the time the algal assay sample was collected (10/04/72), Powder Mill Pond was phosphorus limited; however, Pond data obtained in June and August indicate the Pond was nitrogen limited at those times.

C. Nutrient Controllability:

1. Point sources--During the sampling year, Powder Mill Pond received a total phosphorus load at a rate well in excess of that proposed by Vollenweider (in press) as dangerous (i.e., a eutrophic rate; see page 17). Of this load, it is estimated that the Town of Jaffrey contributed nearly 32%, and the Town of Peterborough contributed about 20% (see Appendix D).

In the following table, the total phosphorus loading rates that can be achieved by the specified levels of phosphorus removal at the two point sources are compared to Vollenweider's suggested rates.

% P Removal	Total P Loading lbs/acre/yr	Total P Loading $g/m^2/yr$
Existing	29.0	3.25
50	21.5	2.40
70	18.4	2.07
80	16.9	1.90
90	15.4	1.73
100	13.9	1.56
Vollenweider ($g/m^2/yr$):		
Dangerous (eutrophic rate)		2.20
Permissible (oligotrophic rate)		1.10

It will be noted that 70% phosphorus removal would result in a loading rate a little less than a eutrophic rate, but none of the above options would result in a permissible or oligotrophic rate.

Although some improvement in the trophic condition of the Pond would be expected with the reduction in phosphorus loading resulting from 80% to 90% phosphorus removal at the point sources, it is questionable whether the degree of improvement would be commensurate with the costs of the high level of phosphorus removal required.

2. Non-point sources--The mean nutrient exports of Powder Mill Pond tributaries were quite low during the sampling year (see page 17) and compared very favorably with Lake Winnipesaukee tributaries (see Working Paper No. 11, "Report on Lake Winnipesaukee").

II. INTRODUCTION

Powder Mill Pond is an impoundment of the Contoocook River near Bennington, New Hampshire. The Pond is owned by Monadnock Paper Mills, Inc., and is controlled for water storage and river flow augmentation; water for mill use is taken from a smaller impoundment just downstream from the Pond (LeCain, 1973).

Reportedly, the Pond provides fair bass fishing, and some boating is done for that purpose. However, there are no boat-launching facilities, and little other recreational use is made of the Pond.

Shoreline development is minimal.

III. LAKE AND DRAINAGE BASIN CHARACTERISTICS

A. Lake Morphometry:

1. Surface area: 372 acres.
2. Mean depth: 8.1 feet.
3. Maximum depth: ? feet.
4. Volume: 3,030 acre/feet*.
5. Mean hydraulic retention time: 6.5 days.

B. Tributary and Outlet:
(See Appendix A for flow data)

1. Tributaries -

Name	Drainage area**	Mean flow**
Contoocook River	108.4 mi^2	177.8 cfs
Moose Brook	13.8 mi^2	22.6 cfs
Unnamed stream (C-1)	3.2 mi^2	5.3 cfs
Ferguson Brook	10.6 mi^2	17.4 cfs
Minor tributaries & immediate drainage -	7.4 mi^2	13.1 cfs
Totals	143.4 mi^2	236.2 cfs

2. Outlet -

Contoocook River	144.0 $mi^{2\dagger}$	236.2 cfs

C. Precipitation††:

1. Year of sampling: 49.6 inches.
2. Mean annual: 43.2 inches.

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* Knowlton, 1974.
** Drainage areas are accurate within ±1%, gaged mean annual flows within ±15%, and ungaged mean annual flows within ±20%.
† Includes area of Pond.
†† See Working Paper No. 1, "Survey Methods".

IV. LAKE WATER QUALITY SUMMARY

Powder Mill Pond was sampled three times during the open-water season of 1972 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from one or more depths at three stations on the Pond, except for station 1 which could not be sampled in October because of a drawdown of the Pond (see Map 1, page v). During each visit, a single depth-integrated (near bottom to surface) sample was composited from the stations for phytoplankton identification and enumeration; and during the last visit, a single five-gallon depth-integrated sample was composited for algal assays. Also each time, a depth-integrated sample was collected from each of the stations for chlorophyll a analysis. The maximum depths sampled were four feet at station 1, five feet at station 2, and four feet at station 3.

The results obtained are presented in full in Appendix B, and the data for the fall sampling period, when the lake was essentially well-mixed, are summarized below. Note, however, the Secchi disc summary is based on all values.

For differences in the various parameters at the other sampling times, refer to Appendix B.

A. Physical and chemical characteristics:

Parameter	Minimum	Mean	Median	Maximum
		FALL VALUES (10/04/72)		
Temperature (Cent.)	15.6	16.0	16.0	16.4
Dissolved oxygen (mg/l)	8.1	8.9	8.9	9.7
Conductivity (μmhos)	80	81	80	84
pH (units)	6.4	6.5	6.5	6.6
Alkalinity (mg/l)	10	10	10	10
Total P (mg/l)	0.026	0.032	0.030	0.041
Dissolved P (mg/l)	0.015	0.016	0.016	0.019
NO_2 + NO_3 (mg/l)	0.050	0.057	0.060	0.060
Ammonia (mg/l)	0.090	0.127	0.105	0.210
		ALL VALUES		
Secchi disc (inches)	36	47	46	61

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Number per ml
06/02/72	1. Navicula	108
	2. Dinobryon	88
	3. Fragilaria	44
	4. Flagellates	42
	5. Synedra	36
	Other genera	258
	Total	576
08/05/72	1. Cyclotella	189
	2. Flagellates	151
	3. Cryptomonas	66
	4. Synedra	24
	5. Dinobryon	22
	Other genera	139
	Total	591
10/04/72	1. Flagellates	2,214
	2. Fragilaria	1,160
	3. Dinobryon	617
	4. Melosira	467
	5. Cyclotella	376
	Other genera	904
	Total	5,738

2. Chlorophyll a -
(Because of instrumentation problems during the 1972 sampling, the following values may be in error by plus or minus 20 percent.)

Sampling Date	Station Number	Chlorophyll a (µg/l)
06/02/72	01	2.2
	02	2.5
	03	3.7
08/05/72	01	2.4
	02	8.6
	03	3.0
10/04/72	01	not done
	02	19.8
	03	7.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.012	0.133	0.2
0.006 P	0.018	0.133	0.6
0.012 P	0.024	0.133	1.9
0.024 P	0.036	0.133	2.2
0.060 P	0.072	0.133	2.4
0.060 P + 10.0 N	0.072	10.133	26.6
10.0 N	0.012	10.133	0.2

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Powder Mill Pond was relatively low at the time the sample was collected. Also, the increased yields with increased

levels of orthophosphorus (up to about 0.020 mg/l), and the lack of response to the addition of nitrogen alone, show that the Pond was phosphorus limited when sampled; however the nitrogen to phosphorus ratios of about 9 to 1 and 10 to 1 in June and August, respectively, indicate nitrogen limitation at those times.

D. Trophic Condition:

Survey data the records of others (Anonymous, 1973) show that Powder Mill Pond is eutrophic, although nuisance algal blooms seldom occur despite a phosphorus loading rate of 29 lbs/acre/yr. However, the very short hydraulic retention time results in a little less than 10% accumulation of the phosphorus reaching the Pond and less than 8% of the nitrogen. It appears the essentially flow-through regime of the Pond is suppressing trophic responses to relatively high nutrient loading rates, although the Pond reportedly supports fairly dense growths of emergent aquatic weeds along the shorelines.

Nuisance algal blooms have occurred in the Pond in the past; however, New Hampshire Water Supply and Pollution Control personnel attribute the blooms to continuations of blooms in Skatutakee Lake some miles upstream on a tributary to the Contoocook River (MacDonald, 1972). Since the termination of an industrial waste discharge to the lake in 1970, no blooms have been reported in either the lake or Powder Mill Pond.

V. NUTRIENT LOADINGS
(See Appendix C for data)

For the determination of nutrient loadings, the New Hampshire National Guard collected monthly near-surface grab samples from the tributary sites indicated on Map 1 (page v), except for the high runoff months of March and April, when two samples were collected, and the colder months of the year when one or more samples were omitted depending on the site. Sampling was begun in August, 1972, and was completed in July, 1973.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the New England District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

With reference to the map on page v, the tributary site originally selected as the Pond inlet (station A-1) was later found to be in the Pond proper. For this reason, in this report station A-2 is considered the inlet, and nutrient loads at that point were determined by using mean annual nutrient concentrations at A-2 and the mean annual flows provided by U.S.G.S. for station A-1. The A-1 flows were adjusted fro station A-2 by subtracting the estimated flows of Ferguson Brook which joins the Contoocook River downstream from A-2.

The flows of Ferguson Brook were estimated on the basis of drainage area (10.6 mi^2) times the mean discharge per square mile for the Contoocook River drainage as determined by U.S.G.S. (1.64 cfs/mi^2). The nutrient loads for

the Brook were calculated using the estimated flow and the mean annual nutrient concentrations of Moose Brook which appears to have very similar drainage characteristics.

Also, it will be noted that the unnamed stream draining Whittemore Lake is not a Powder Mill Pond tributary. Sampling of this stream was conducted at station C-1 to establish nutrient concentrations for the calculation of immediate drainage area nutrient loads (tributary "ZZ" in U.S.G.S. flow data, Appendix A) and to permit adjustments of nutrient loads leaving the system at station A-6 in Bennington, since it was impractical to sample the outlet of Powder Mill Pond directly. Further, the Monadnock Paper Mills diverts about 312 million gallons per year from a smaller impoundment just below the Pond but above station A-6; therefore, nutrient losses through the diversion were added to A-6 loads (i.e., A-6 loads plus diversion loads minus C-1 loads = Pond outlet loads).

Discharges from the Peterborough wastewater ponds were sampled by the operator on a monthly basis, and flow data were provided. However, the Jaffrey operator provided only four usable samples (Appendix C); and the Jaffrey loads were calculated on that basis. The resulting loads were of the same order as would have been estimated by using 2.5 lbs P and 7.5 lbs N/capita/yr.

The D. D. Bean & Sons Company at Jaffrey daily contributes from 200 to 300 gallons of match-dip process wash waters to the Jaffrey system. The effect of this phosphorus source on the phosphorus load in the Jaffrey effluent is not known; but, considering the rather small volume, the

source probably was not significant. Also, the Noone Woolen Mills discharge to the Peterborough system apparently did not increase nutrient loads from that source appreciably.

During the sampling year, the combined phosphorus loads from the Jaffrey and Peterborough treatment facilities exceeded the entire phosphorus load measured at A-2 (thus indicating sedimentation and/or biological assimilation of some portion of the point-source phosphorus loads in the system). Therefore, in the following phosphorus loading table, the loads attributed to Jaffrey, Peterborough, and the Contoocook River at A-2 were adjusted as outlined in Appendix D. Note, however, that nitrogen loads were not adjusted, and the load attributed to the Contoocook River is that measured at A-2 <u>minus</u> the point-source loads.

A. Waste Sources:

1. Known municipal -

Name	Pop. Served*	Treatment	Mean Flow (mgd)	Receiving Water
Jaffrey	2,000	stab. ponds	0.661	Contoocook River
Peterborough	2,000	stab. ponds	0.293	Concoocook River

2. Known industrial** -

Name	Treatment	Mean Flow (gpd)	Receiving Water
D. D. Bean & Sons Co., Jaffrey	(to Jaffrey system)	200-300	(Contoocook River)
Noone Woolen Mills, Peterborough	(to Peterborough system)	50,000-100,000	(Contoocook River)

* Anonymous, 1973.
** MacDonald, 1973.

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	lbs P/ yr	% of total
a. Tributaries (non-point load)		
Contoocook River	3,850	35.7
Moose Brook	580	5.4
Ferguson Brook	450	4.2
b. Minor tributaries & immediate drainage (non-point load) -	230	2.1
c. Known municipal -		
Jaffrey	3,410	31.6
Peterborough	2,190	20.3
d. Septic tanks* -	10	0.1
e. Known industrial -		
D. D. Bean & Sons Co.	(to Jaffrey system)	
Noones Woolen Mill	(to Peterborough system)	
f. Direct precipitation** -	60	0.6
Total	10,780	100.0

2. Outputs -

Lake outlet - Contoocook River 9,730

3. Net annual P accumulation - 1,050 pounds

* Estimated 20 shoreline dwellings; see Working Paper No. 1, "Survey Methods".
** See Working Paper No. 1.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	lbs N/ yr	% of total
a. Tributaries (non-point load) -		
Contoocook River	150,910	71.6
Moose Brook	14,220	6.7
Ferguson Brook	10,920	5.2
b. Minor tributaries & immediate drainage (non-point load) -	5,920	2.8
c. Known municipal -		
Jaffrey	16,830	8.0
Peterborough	7,970	3.8
d. Septic tanks * -	470	0.2
e. Known industrial -		
D. D. Bean & Sons Co.	(to Jaffrey system)	
Noones Woolen Mill	(to Peterboroug system)	
f. Direct precipitation** -	3,580	1.7
Total	210,820	100.0

2. Outputs -

Lake outlet - Contoocook River 194,960

3. Net annual N accumulation - 15,860 pounds

* Estimated 20 shoreline dwellings; see Working Paper No. 1, "Survey Methods".
** See Working Paper No. 1.

D. Mean Annual Non-point Nutrient Export by Subdrainage Area:

Tributary	lbs P/mi^2/yr	lbs N/mi^2/yr
Contoocook River	36	1,392
Moose Brook	42	1,030
Ferguson Brook	42	1,030
Unnamed stream (C-1)	29	740

E. Yearly Loading Rates:

In the following table, the existing phosphorus loading rates are compared to those proposed by Vollenweider (in press). Essentially, his "dangerous" rate is the rate at which the receiving water would become eutrophic or remain eutrophic; his "permissible" rate is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic rate would be considered one between "dangerous" and "permissible".

Units	Total Phosphorus		Total Nitrogen	
	Total	Accumulated*	Total	Accumulated*
lbs/acre/yr	29.0	2.8	566.7	42.6
grams/m^2/yr	3.25	0.32	63.5	4.8

Vollenweider loading rates for phosphorus (g/m^2/yr) based on mean depth and mean hydraulic retention time of Powder Mill Pond:

"Dangerous" (eutrophic rate)	2.20
"Permissible" (oligotrophic rate)	1.10

* The indicated nutrient accumulations probably are too high. The Pond outlet was not sampled directly; but at least one downstream reservoir intervenes between the Pond outlet and the sampling station at A-6, and some portion of the "accumulated" nutrients must have been trapped there. Further, the fall Pond drawdown observed by EPA limnologists does not appear to be reflected in the A-6 flows provided by U.S.G.S.; adjustment of these flows to include the drawdown would result in greater amounts of nutrients in the outflow and, therefore, lesser amounts of accumulated nutrients.

VI. LITERATURE REVIEWED

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TRIBUTARY FLOW INFORMATION FOR NEW HAMPSHIRE 7/9/74

LAKE CODE 3302 POWDER MILL POND

TOTAL DRAINAGE AREA OF LAKE 144.00

TRIBUTARY	SUB-DRAINAGE AREA	NORMALIZED FLOWS JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
3302A1	119.00	198.00	183.00	314.00	572.00	284.00	150.00	68.90	52.10	71.80	96.90	175.00	181.00	195.15
3302A6	144.00	239.00	222.00	380.00	693.00	344.00	181.00	83.40	63.10	86.80	117.00	212.00	219.00	236.19
3302H1	13.80	22.90	21.30	36.40	66.40	33.00	17.40	7.99	6.04	8.32	11.20	20.30	21.00	22.64
3302C1	3.20	5.31	4.93	8.45	15.40	7.65	4.03	1.85	1.40	1.93	2.60	4.70	4.86	5.25
3302Z7	8.00	13.30	12.30	21.10	38.50	19.10	10.10	4.63	3.50	4.82	6.51	11.80	12.20	13.13

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 144.00
SUM OF SUB-DRAINAGE AREAS = 144.00
TOTAL FLOW IN = 2839.92
TOTAL FLOW OUT = 2840.30

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW
3302A1	8	72	52.60	26	35.00		
	9	72	31.50	9	29.80		
	10	72	67.70	1	31.40		
	11	72	266.00				
	12	72	272.00				
	1	73	396.00	6	192.00		
	2	73	458.00	11	211.00		
	3	73	597.00	11	549.00	25	386.00
	4	73	535.00	15	377.00	30	413.00
	5	73	335.00	20	298.00		
	6	73	188.00	10	141.00		
	7	73	212.00	7	248.00		
3302A6	8	72	63.70	26	42.30		
	9	72	38.10	9	36.00		
	10	72	81.80	1	38.00		
	11	72	322.00				
	12	72	328.00				
	1	73	478.00	6	232.00		
	2	73	555.00	11	255.00		
	3	73	722.00	11	664.00	25	467.00
	4	73	649.00	15	456.00	30	500.00
	5	73	406.00	20	360.00		
	6	73	226.00	10	170.00		
	7	73	256.00	7	301.00		

LAKE CODE 3302 SUNDAY HILL POND

MEAN MONTHLY FLOWS AND DAILY FLOWS

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
330201	8	72	6.10	26	4.06				
	9	72	3.65	9	3.45				
	10	72	7.33	1	3.64				
	11	72	30.90						
	12	72	31.50						
	1	73	45.30	6	22.20				
	2	73	53.20	11	24.40				
	3	73	59.20	11	63.60	25	44.70		
	4	73	62.10	15	43.70	30	47.90		
	5	73	39.00	20	34.50				
	6	73	21.80	10	16.30				
	7	73	24.50	7	28.80				
330201	8	72	1.41	26	0.94				
	9	72	0.85	9	0.80				
	10	72	1.42	1	0.85				
	11	72	7.14	4	3.05				
	12	72	7.29						
	1	73	10.60	6	5.15				
	2	73	12.30	11	5.66				
	3	73	16.10	11	14.80	25	10.40		
	4	73	14.40	15	10.10	30	11.10		
	5	73	9.60	20	8.00				
	6	73	5.00	10	3.80				
	7	73	5.70	7	6.70				
330277	8	72	3.54						
	9	72	2.12						
	10	72	4.55						
	11	72	17.90						
	12	72	18.30						
	1	73	25.60						
	2	73	30.80						
	3	73	40.10						
	4	73	36.00						
	5	73	22.60						
	6	73	12.60						
	7	73	14.20						

APPENDIX B

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 74/07/02

330201
42 57 00.0 071 56 00.0
POWDER MILL POND
33003 NEW HAMPSHIRE

11EPALES 2111202
5 0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	06 15	0000	16.4		42			10K	0.070	0.070	0.024	0.015
72/08/05	10 10	0000			48	75	6.10	10K	0.150	0.120	0.053	0.027
	10 10	0004	20.4	6.4		110	6.20	10K	0.150	0.050	0.094	0.024

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	06 15	0000	2.2J
72/08/05	10 10	0000	2.4J

STORET RETRIEVAL DATE 74/07/02

330202
42 5R 00.0 071 56 00.0
POWDER MILL POND
33 NEW HAMPSHIRE

11EPALES 2111202
5 0006 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	06 40	0000	16.7	9.2	46	30		10K	0.070	0.060	0.026	0.014
	06 40	0004	16.7	7.6		40	5.90	10K	0.060	0.060	0.024	0.015
72/08/05	10 25	0000	20.8		51	65	6.30	10K	0.100	0.170	0.054	0.023
	10 25	0005	20.5	7.2		65	6.30	10K	0.080	0.120	0.053	0.026
72/10/04	17 35	0000				80	6.48	10K	0.060	0.100	0.033	0.015
	17 35	0003	16.4	9.7		80	6.60	10K	0.060	0.090	0.041	0.019

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	06 40	0000	2.5J
72/08/05	10 25	0000	4.6J
72/10/04	17 35	0000	19.8J

STORET RETRIEVAL DATE 74/07/02

330203
42 59 06.0 071 56 00.0
POWDER MILL POND
33 NEW HAMPSHIRE

11EPALES
5

2111202
0010 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00630 NO2&NO3 N-TOTAL MG/L	00610 NH3-N TOTAL MG/L	00665 PHOS-TOT MG/L P	00666 PHOS-DIS MG/L P
72/06/02	07 05	0000	18.1		46			10K	0.090	0.080	0.023	0.011
	07 05	0003	18.2	7.6		60	6.10	10K	0.060	0.030	0.023	0.013
72/08/05	10 35	0000			61	65	6.20	10K	0.100	0.170	0.041	0.022
	10 35	0001	22.1									
	10 35	0004	22.0	6.4		65	6.20	10K	0.080	0.130	0.043	0.016
72/10/04	17 15	0000			36	84	6.60	10K	0.050	0.210	0.027	0.017
	17 15	0004	15.6	8.1		80	6.40	10K	0.050	0.110	0.026	0.015

DATE FROM TO	TIME OF DAY	DEPTH FEET	32217 CHLRPHYL A UG/L
72/06/02	07 05	0000	3.7J
72/08/05	10 35	0000	3.0J
72/10/04	17 15	0000	7.3J

APPENDIX C

TRIBUTARY and WASTEWATER TREATMENT PLANT DATA

STORET RETRIEVAL DATE 74/07/02

3302A1 LS3302A1
42 57 30.0 071 56 00.0
CONTOOCOOK RIVER
33003 15 PETERBOROUGH
I/POWDER MILL POND
NH BRDG 8,NH SAMPLE SITE 25
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	12 45		0.035	0.600	0.015	0.020	0.031
72/09/09	12 10		0.160	0.510	0.081	0.010	0.038
72/11/04	09 00		0.115	0.370	0.126	0.010	0.035
73/03/11	10 10		0.096	0.200	0.048	0.007	0.020
73/03/25	11 30		0.079	0.250	0.034	0.006	0.015
73/04/15	11 45		0.063	0.230	0.030	0.006	0.015
73/04/30	11 00		0.048	0.260	0.027	0.010	0.020
73/05/20	09 00		0.046	0.290	0.025	0.011	0.025
73/06/10	12 00		0.062	0.690	0.028	0.008	0.035
73/07/07	13 10		0.036	0.460	0.029	0.009	0.035

STORET RETRIEVAL DATE 74/07/02

3302A2 LS3302A2
42 56 30.0 071 57 00.0
CONTOOCOOK RIVER
33 15 PETERBOROUGH
I/POWDER MILL POND
BRDG SE OF HANCOCK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	13 15		0.063	0.400	0.016	0.005K	0.036
72/09/09	10 30		0.156	0.500	0.086	0.021	0.037
72/10/01	11 10		0.190	0.300	0.110	0.015	0.038
72/11/04	09 20		0.120	0.780	0.330	0.007	0.030
73/01/06	11 05		0.097	0.320	0.048	0.007	0.015
73/02/11	09 50		0.093	0.720	0.126	0.014	0.015
73/03/11	10 35		0.100	0.280	0.048	0.008	0.020
73/03/25	18 30		0.079	0.320	0.041	0.005K	0.015
73/04/15	10 45		0.067	0.215	0.025	0.006	0.015
73/04/30	11 30		0.048	0.310	0.022	0.011	0.022
73/05/20	13 10		0.042	0.290	0.022	0.010	0.030
73/06/10	12 30		0.052	0.405	0.056	0.006	0.035
73/07/08	10 40		0.036	0.540	0.027	0.007	0.040

STORET RETRIEVAL DATE 74/07/02

3302A3 LS3302A3
42 54 00.0 071 56 30.0
CONTOOCOOK RIVER
33 15 PETERBOROUGH
I/POWDER MILL POND
US 202 BRDG AT NORTH VILLAGE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	13 40		0.126	0.600	0.061	0.028	0.044
72/09/09	09 40		0.130	0.470	0.078	0.019	0.039
72/10/01	10 55		0.220	0.600	0.132	0.027	0.054
72/11/04	10 30		0.117	0.400	0.132	0.018	0.038
73/01/06	10 35		0.100	0.290	0.054	0.009	0.015
73/02/11	09 40		0.087	0.240	0.032	0.005K	0.010
73/03/11	10 50		0.097	0.390	0.056	0.007	0.015
73/03/25	19 10		0.078	0.180	0.036	0.005K	0.015
73/04/15	10 25		0.066	0.180	0.015	0.006	0.015
73/04/30	10 30		0.048	0.270	0.020	0.008	0.020
73/05/20	13 10		0.042	0.290	0.014	0.007	0.020
73/06/10	12 15		0.056	0.460	0.037	0.007	0.035
73/07/08	10 50		0.030	0.560	0.016	0.006	0.040

STORET RETRIEVAL DATE 74/07/02

3302A4 LS3302A4
42 50 00.0 071 59 00.0
CONTOOCOOK RIVER
33 15 PETERBOROUGH
I/POWDER MILL POND
ON US202 AT HADLEY BELO JAFFREY STP
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	14 30		0.061	0.600	0.088	0.084	0.130
72/09/09	09 50		0.156	1.180	0.260	0.084	0.160
72/10/01	10 30		0.221	1.550	0.810	0.350	0.540
72/11/04	09 30		0.143	0.790	0.378	0.063	0.150
73/01/06	10 05		0.110	0.480	0.140	0.021	0.030
73/02/11	09 17		0.138	0.390	0.130	0.024	0.035
73/03/11	11 45		0.132	0.480	0.120	0.019	0.030
73/03/25	13 00		0.088	0.210	0.072	0.011	0.025
73/04/15	10 05		0.056	0.340	0.038	0.009	0.025
73/04/30	12 30		0.036	0.290	0.032	0.019	0.035
73/05/20	12 45		0.040	0.400	0.054	0.018	0.045
73/06/10	12 00		0.038	0.690	0.073	0.038	0.090
73/07/08	11 15		0.044	0.610	0.063	0.032	0.065

STORET RETRIEVAL DATE 74/07/02

3302AS LS3302AS
42 49 00.0 072 00 30.0
CONTOOCOOK RIVER
33 15 MONADNOCK
I/POWDER MILL POND
DOWNSTREAM END OF CHESHIRE POND
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	14 45		0.010K	0.400	0.038	0.010	0.023
72/09/09	09 05		0.078	0.610	0.115	0.010	0.031
72/10/01	10 00		0.091	0.850	0.198	0.007	0.042
73/01/06	09 50		0.092	0.350	0.095	0.005K	0.015
73/02/11	09 11		0.126	0.370	0.050	0.005K	0.010
73/03/11	12 05		0.110	0.260	0.050	0.005K	0.010
73/03/25	12 55		0.075	0.180	0.029	0.005K	0.010
73/04/15	09 50		0.037	0.540	0.017	0.005K	0.010
73/04/30	13 00		0.023	0.400	0.022	0.007	0.020
73/05/20	12 30		0.029	0.290	0.035	0.005K	0.025
73/06/10	12 40		0.025	0.600	0.019	0.005K	0.030
73/07/08	11 25		0.023	0.500	0.026	0.005K	0.030

STORET RETRIEVAL DATE 74/07/02

3302A6 LS3302A6
43 00 00.0 071 55 30.0
CONTOOCOOK RIVER
33 15 HILLSBORO
O/POWDER MILL POND
ST HWY 31 BRDG
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	11 45		0.028	0.400	0.028	0.017	0.032
72/09/09	09 20		0.053	0.350	0.092	0.009	0.023
72/10/01	12 50		0.060	0.350	0.097	0.007	0.028
72/11/04	14 00		0.077	0.480	0.092	0.005K	0.030
73/01/06	09 30		0.087	0.290	0.060	0.007	0.015
73/02/11	09 00		0.084	0.170	0.031	0.005K	0.010
73/03/11	09 20		0.093	0.250	0.050	0.007	0.015
73/03/25	12 30		0.066	0.140	0.028	0.005K	0.015
73/04/15	11 15		0.048	0.960	0.017		0.015
73/04/30	11 50		0.046	0.290	0.020	0.010	0.020
73/05/20	11 00		0.039	0.280	0.018	0.006	0.020
73/06/10	13 05		0.026	0.360	0.018	0.005K	0.025
73/07/07	13 45		0.034	0.420	0.024	0.007	0.025

STORET RETRIEVAL DATE 74/07/02

3302B1 LS3302B1
42 58 30.0 071 56 30.0
MOOSE BROOK
33 15 PETERBOROUGH
T/POWDER MILL POND
BRDG AT ELMWOOD
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	12 30		0.076	0.300	0.025	0.005K	0.022
72/09/09	11 23		0.063	0.300	0.096	0.016	0.019
72/10/01	11 21		0.059	0.250	0.080	0.005K	0.018
72/11/04	11 05		0.032	0.400	0.115	0.005K	0.013
73/03/11	09 45		0.034	0.270	0.017	0.005K	0.005K
73/03/25	11 45		0.021	0.220	0.025	0.005K	0.005K
73/04/15	12 00		0.018	0.130	0.006	0.005K	0.005K
73/04/30	10 45		0.012	0.230	0.016	0.005K	0.010
73/05/20	09 30		0.010K	0.250	0.007	0.005K	0.010
73/06/10	12 50		0.026	0.360	0.015	0.005K	0.020
73/07/07	13 30		0.031	0.420	0.020	0.005K	0.020

STORET RETRIEVAL DATE 74/07/02

3302C1 LS3302C1
42 59 30.0 071 55 30.0
NO NAME
33 15 PETERBOROUGH
O/POWDER MILL POND
NH SAMPLE SITE 248
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	12 05		0.075	0.200	0.042	0.005K	0.009
72/09/09	10 04		0.067	0.100K	0.038	0.006	0.010
72/10/01	12 15		0.042	0.100K	0.058	0.005K	0.008
72/11/04	10 30		0.033	0.210	0.078	0.005K	0.006
73/02/11	09 15		0.069	0.100K	0.010	0.005K	0.005K
73/03/11	09 00		0.056	0.220	0.027	0.005K	0.005K
73/03/25	12 15		0.048	0.180	0.019	0.005K	0.005K
73/04/15	11 00		0.060	0.420	0.007	0.005K	0.005K
73/04/30	11 45		0.036	0.100K	0.012	0.006	0.010
73/05/20	10 00		0.029	0.150	0.007	0.005K	0.005K
73/06/10	13 20		0.044	0.100K	0.010	0.005K	0.015
73/07/07	14 10		0.054	0.330	0.018	0.005K	0.025

STORET RETRIEVAL DATE 74/07/02

3302D1 LS3302D1
42 54 00.0 071 56 30.0
NO NAME
33 15 PETERBOROUGH
T/POWDER MILL POND
US 202 BRDG AT NORTH VILLAGE
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
72/08/26	13 45		0.119	0.300	0.032	0.046	0.058
72/09/09	09 30		0.130	0.400	0.073	0.019	0.044
72/11/04	10 20		0.100	0.340	0.126	0.018	0.038
73/01/06	10 40		0.095	0.330	0.071	0.008	0.020
73/02/11	09 35		0.088	0.290	0.040	0.005K	0.012
73/03/11	10 40		0.189	0.310	0.072	0.005K	0.015
73/03/25	13 15		0.075	0.170	0.035	0.005K	0.015
73/04/15	10 20		0.065	0.250	0.018	0.006	0.015
73/04/30	10 30		0.048	0.500	0.036	0.008	0.020
73/05/20	13 00		0.042	0.340	0.011	0.005K	0.020
73/06/10	12 10		0.050	0.380	0.024	0.007	0.035
73/07/08	11 00		0.030	0.560	0.018	0.005K	0.045

STORET RETRIEVAL DATE 74/07/02

330250 P0330250 P001200
42 49 00.0 072 01 30.0
JAFFREY
33003 15 MONODNOCK
T/POWDER MILL POND
CONTOOCOOK RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
73/10/03	08 00		0.340	9.800	2.450	3.900	4.500		
73/10/14	07 00								
CP(T)-			0.400	15.500	2.510	4.100	6.000	0.021	0.230
73/10/14	18 00								
74/02/13	09 00								
CP(T)-			0.080	8.400	4.700	2.800	3.100	0.252	0.288
74/02/13	13 00								
74/03/11	07 00								
CP(T)-			0.040	9.800	0.083	0.050K	3.100	0.450	0.325
74/03/11	18 00								
74/04/30	07 00								
CP(T)-			0.160	7.600	1.800	1.900	2.900	1.440	1.800
74/04/30	19 00								

STORET RETRIEVAL DATE 74/07/02

330251 NO330251 P000300
42 52 00.0 072 57 00.0
PETERBORO
33 15 PETERBOROUGH
T/POWDER MILL POND
CONTOOCOOK RIVER
11EPALES 2141204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P	50051 FLOW RATE INST MGD	50053 CONDUIT FLOW-MGD MONTHLY
72/12/04	08	00	0.120	3.100	0.096	1.075	1.440	0.179	0.278
73/01/01	09	00	0.097	4.500	2.000	1.800	2.100	0.472	0.275
73/02/01	11	00	0.110	11.000	7.950	3.040	3.400	0.251	0.588
73/03/01	08	00	0.123	13.000	9.400	3.800	3.900	0.354	0.565
73/05/02	08	30	0.710	7.100		1.845	2.500	0.264	0.302
73/07/02	11	00	0.320	1.890	0.190			0.500	0.244
73/08/01	09	00	0.090	2.700	0.420	2.100	2.700	0.216	0.197
73/12/03	09	30	0.240	9.400	5.000	3.900	4.400	0.085	0.095
73/12/31	08	00	0.240	12.500	5.600	5.300	6.200	0.501	0.250
74/02/01	09	30	0.040	12.000	0.170	6.000	6.800	0.359	0.402
74/03/11	08	00	0.040	12.000	0.210	0.120	6.600	0.140	0.199
74/04/01	08	00	0.240	13.000	6.200	3.900	4.900	0.134	0.135
74/05/03	10	00	0.320	14.000	8.000	5.000	5.300	0.357	0.275

JAFFREY and PETERBOROUGH
PHOSPHORUS LOADS

In the initial analysis of the phosphorus regime of the Powder Mill Pond drainage, it became obvious that there was more than the expected degree of entrapment of phosphorus in the Contookcook River. On Map 2, following, the phosphorus loads calculated for each of the tributary sampling sites (flows adjusted) are shown. It will be noted that there was a progressive decline in loads from station A-4 (below the Jaffrey outfall) to the Pond inlet at A-2 (about 14 stream miles) because of sedimentation and/or biological assimilation in impoundments along the river as at Noone, in Peterborough, and at North Village, as well as sedimentation in the river itself, as between A-3 and A-2.

Because of these losses in the system, it was necessary to calculate the phosphorus contributions from Jaffrey and Peterborough indirectly (the phosphorus loads from these two sources, collectively, were greater at the points of discharge than the entire phosphorus load measured at A-2), and the following rationale was used to estimate the phosphorus loads reaching Powder Mill Pond:

1. The mean P load of B-1 and C-1 (both without point sources) = 35.5 lbs/mi^2/yr;

2. 35.5 x 108.4 mi^2 (area of Contoocook River drainage at A-2) = 3,850 lbs P/yr due to non-point sources;

3. Then 9,450 lbs (P load measured at A-2) - 3,850 lbs = 5,600 lbs P/yr attributable to the two point sources.

4. The combined phosphorus loads measured at Jaffrey (6,030 lbs) and Peterborough (3,860 lbs) - 9,890 lbs,

so

Jaffrey = $\frac{6,030}{9,890}$ x 5,600 = 3,410 lbs/yr (rounded),

or 31.6% of the total load; and Peterborough =

$\frac{3,860}{9,890}$ x 5,600 = 2,190 lbs/yr, or 20.3% of the total phosphorus load reaching station A-2.